Option Consideration Paper and Budget Estimation

Group SD0809

Directional Coupler

Option consideration paper
Directional Coupler
Group- 0809

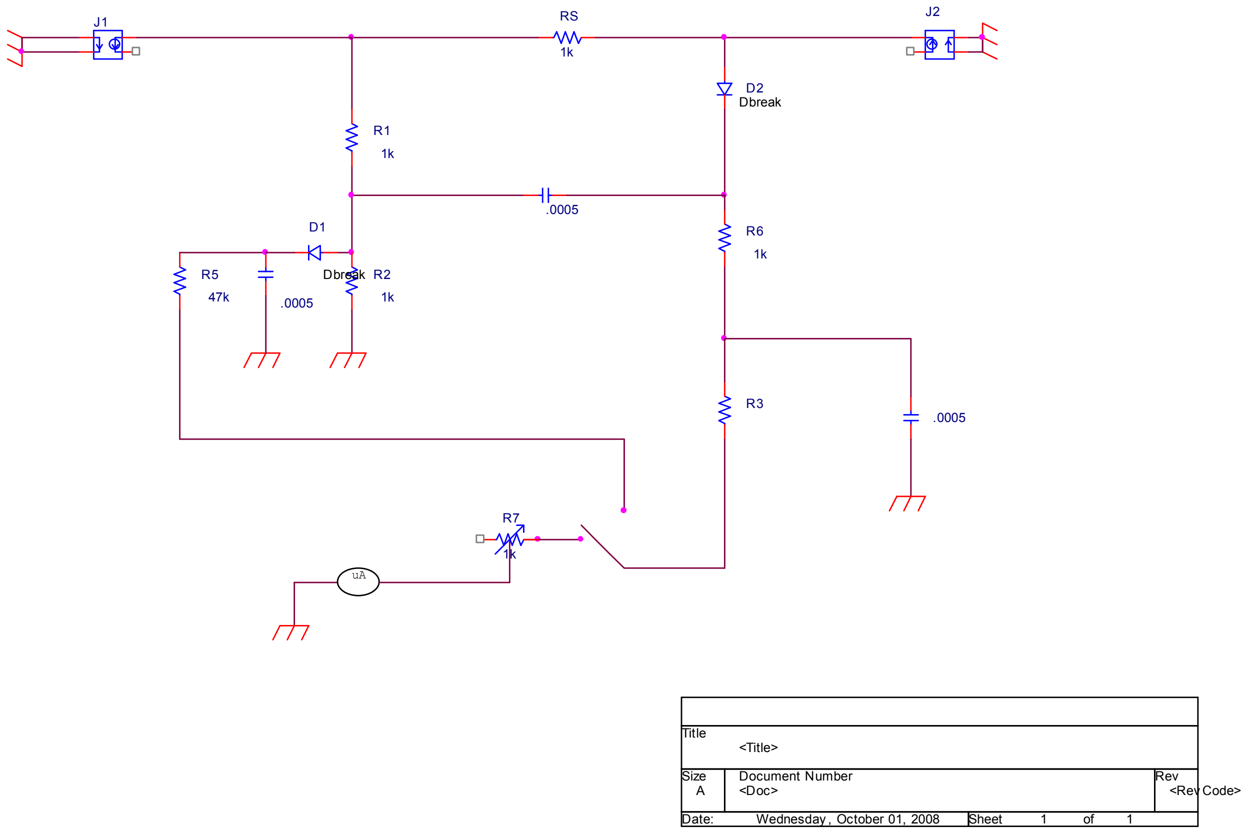
The primary goal of this project is to design and construct three or four devices that measure the VSWR in the frequency range 1.8 to 144 MHz and compete with the directional coupler those used in ECE labs clearly demonstrating the basic science and engineering of the device. Basically each of these devices will be appropriate for the class room demonstration of the concepts of VSWR, forward power, reverse power and/or related concepts. Common properties desired for all directional couplers are wide operational bandwidth, high directivity, and a good impedance match at all ports when the other ports are terminated in matched loads. These performance characteristics play vital role for the accuracy of the directional couplers and our main focus will be to achieve accuracy that can compete with those available in the market. Out of these four directional couplers the first device will be based on simple principles, that is, it might just provide a good estimate of VSWR, and then we will move on to a more sophisticated and accurate one.

There are several ways of designing directional couplers:-

1.) Using coaxial lines
2.) Resistance bridge
3.) Reflectometers
4.) Tandem match

Coaxial lines:
On parallel-conductor lines it is possible to measure the standing wave ratio (SWR) by moving a current (/voltage) indicator along the line, noting the maximum and minimum values of current (/voltage) and then computing the SWR from these measured values. This cannot be done with the coaxial lines since, it uses slaughted lines technique it is not possible to make measurements of this type inside the cable. The technique is, in fact, seldom used with open lines, because it is not only inconvenient but sometimes impossible to reach all ports of the line conductors. Also the method is subject to considerable errors from antenna currents flowing on the line.

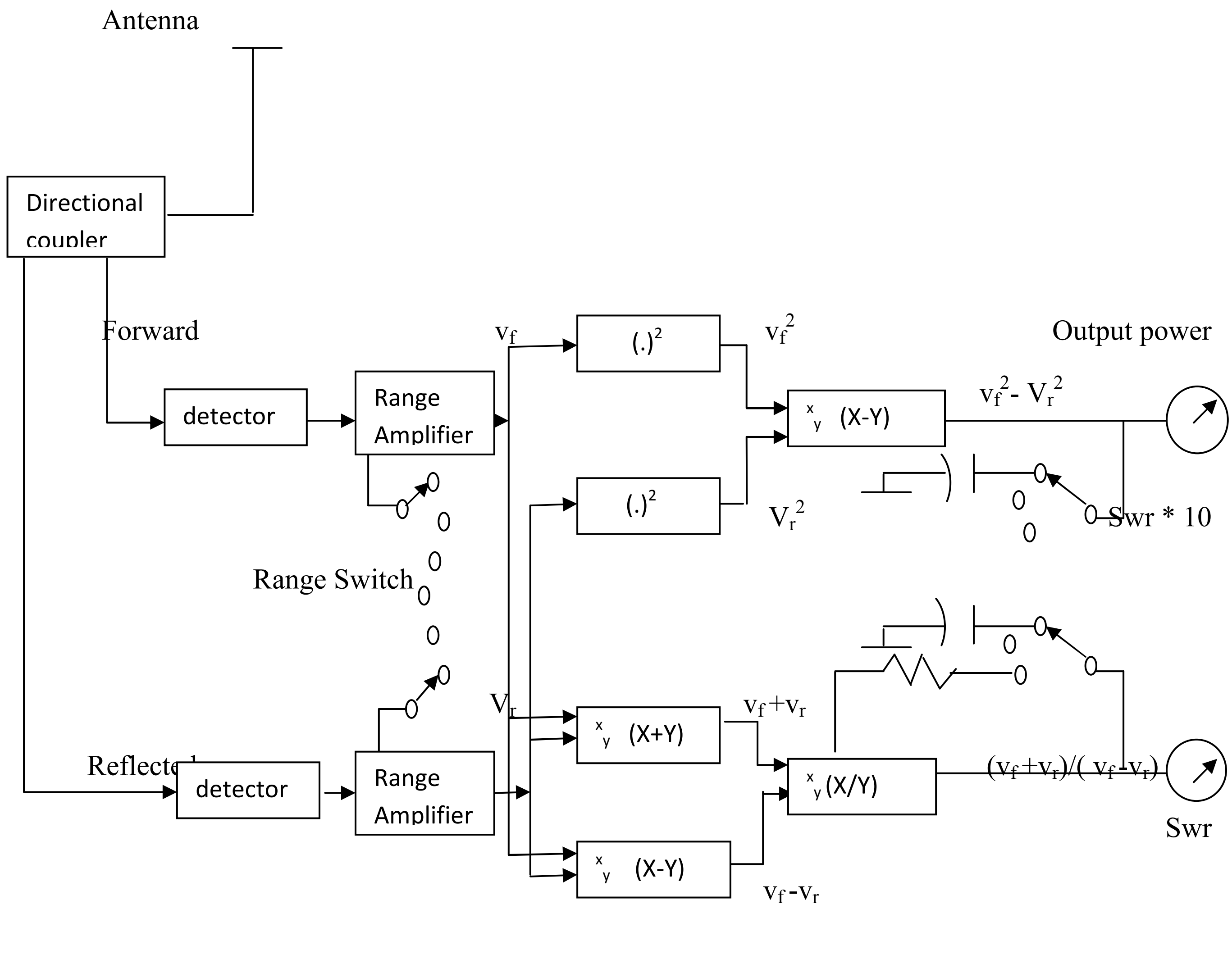
Resistance Bridge:
RF bridges are more common these days for the measurement of SWR. The indicator circuits themselves are fundamentally simple. The requirements for the indicators used only for the adjustment of impedance-matching circuits, rather than actual SWR measurement.



Circuit Diagram

Reflectometers:
These devices are not good at numerical SWR measurement, they are, however, very useful as aids in the adjustment of matching networks, since the objective in such adjustment is to reduce the reflected voltage or power to zero. These devices are frequency sensitive, that is, the meter response becomes greater with increasing frequency, for the same applied voltage.

Tandem match:
Directional couplers designed using tandem match are more accurate at lower power as compared to those designed using any other method described above, because the detector diodes do not respond to low voltage in a linear fashion. This design uses a compensating circuit to cancel diode nonlinearity. It also provides the peak detection for SSB operation and direct SWR readout that does not vary with power level.



Block Diagram

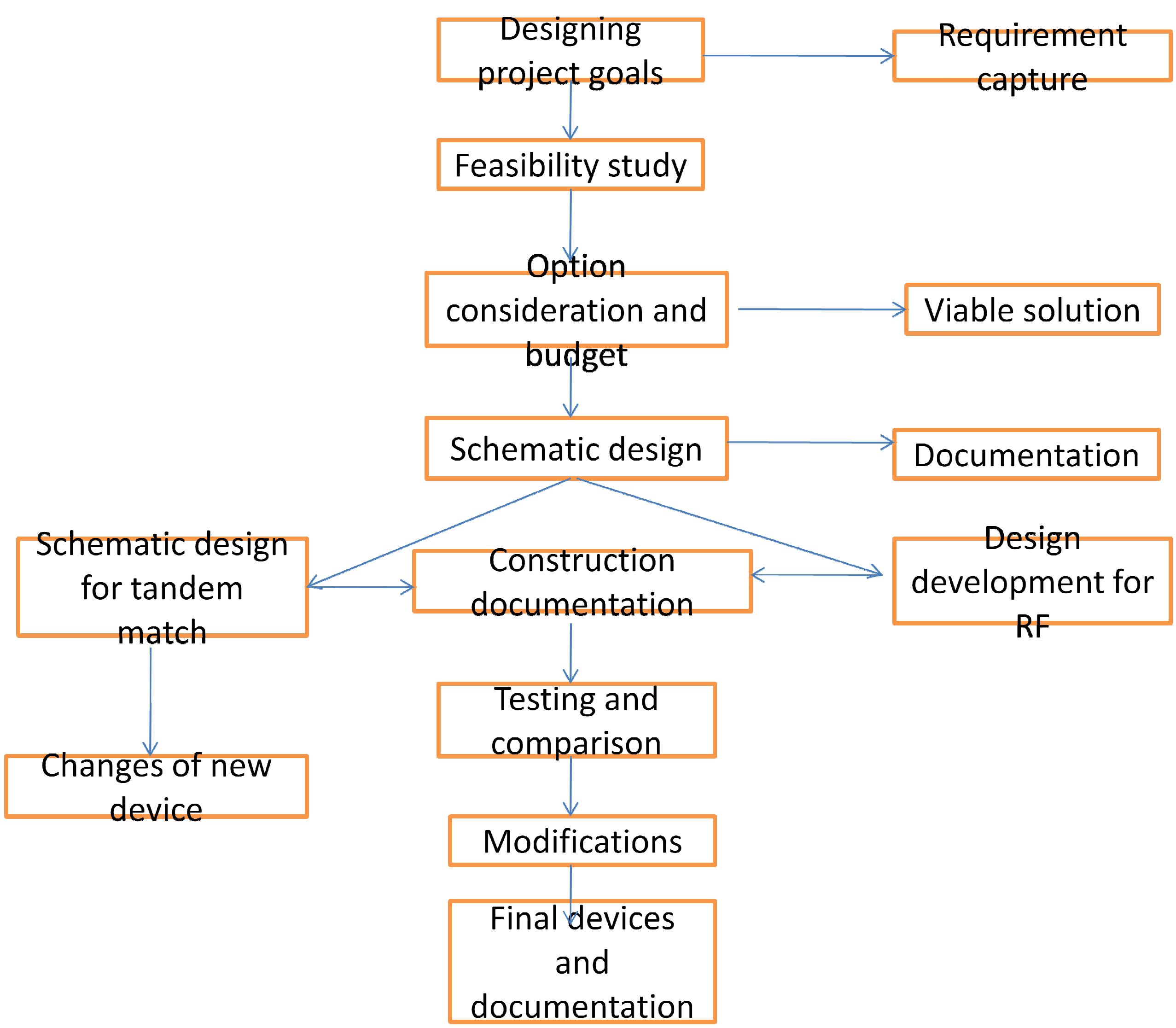
After going through all these details and discussions we have decided to start our project initially by designing a directional coupler using the RF bridge as this the best, simplest and cheapest design which can be used in the classroom demonstration to explain the basic concept behind SWR measurement this device will cover 1.8 to 50 MHz of frequency range and as per the project requirement will work on low power.

As per our project requirement we have to build two or three more devices which should be more accurate and should also cover a frequency range up to 144MHZ, so for the rest of the devices we will be using the tandem match design as it is more accurate, although it works only from 1.8 to 54MHz, but it is possible to make some changes in the configuration so that it can work up to 150MHZ.

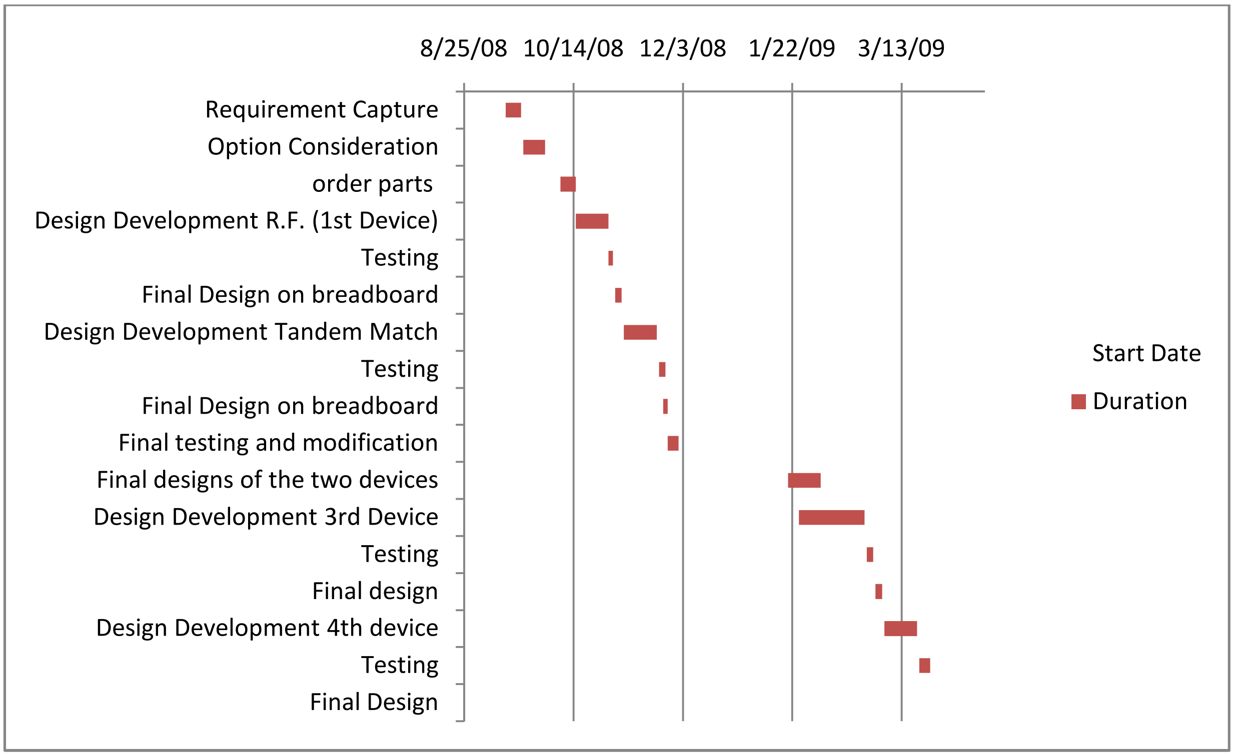
So our basic approach towards our project will be starting with a simpler device using RF Bridge which gives a relative measure of SWR but will help in understanding the basic principle of SWR measurement using directional couplers. After completing this we will start working on a more sophisticated and accurate device in which we will be using tandem match design. This device will be able to work in frequency range of 1.8 to 54MHz. Our main aim for the third device will be to work using the same tandem match design principle but to build up a device which will be capable of working on higher frequencies up to 150MHZ.

As stated in our requirement capture, if we are still left with some more time then, we will be working on a fourth device using an open wire line that will demonstrate an actual voltage standing wave and allow for direct measurement of VSWR.

Flow Chart of Project:



Gantt chart:



This chart is subject to changes depending on the circumstances in future, especially the fourth design which will be started only if the time permits, as our main aim will be to design the three device as good as possible and the if we will still have time left and the things go according to the above Gantt chart then we will surely work on the fourth design.